

Claims

1. A method of error compensation for measurements taken using a co-ordinate positioning apparatus
5 comprising an articulating probe head having a surface detecting device, wherein the surface detecting device is rotated about at least one axis of the articulating probe head during measurement, the method comprising the following steps in any suitable order:
 - 10 (a) determining the stiffness of the whole or part of the apparatus;
 - (b) determining the load or one or more factors which relate to the load applied by the articulating probe head at any particular instant;
 - 15 (c) determining the measurement error at the surface sensing device caused by the load, using the data from steps (a) and (b).
2. A method according to claim 1 wherein the load
20 comprises a torque.
3. A method according to any preceding claim wherein the load comprises a linear force.
- 25 4. A method according to any preceding claim wherein the surface sensing device is a contact probe.
5. A method according to any of claims 1-3 wherein the surface sensing device is a non-contact probe.
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6. A method according to any preceding claim wherein the stiffness is determined in step (a) by applying a load to the whole or part of the apparatus and measuring the deflection.

7. A method according to any of claims 1-5 wherein the stiffness is determined in step (a) by:

measuring an object of known dimensions whilst
5 measuring the load applied to the whole or part of the apparatus;

wherein the deflection of the whole or part of the apparatus is determined from the difference between the known and measured dimensions of the object; and

10 wherein the stiffness is derived from the load and the deflection.

8. A method according to claim 7 wherein the known dimensions of the object are determined by measuring it
15 at a slow speed.

9. A method according to any of claims 1-5 wherein the surface sensing device is a contact probe having a workpiece contacting stylus, and wherein the stiffness
20 is determined in step (a) by:

positioning the contact probe so that the stylus is in contact with the surface of an object of known dimensions;

taking measurement readings of the surface when
25 different probe forces are applied;

wherein the deflection of the whole or part of the apparatus is determined from the difference between the known and measured dimensions; and

wherein the stiffness is derived from the applied
30 force and the deflection.

10. A method according to any of claims 1-5 wherein the surface sensing device is a contact probe having a workpiece contacting stylus, and wherein the stiffness.

is determined in step (a) by:

positioning the contact probe so that the stylus is in contact with the surface of an object of known dimensions;

5 oscillating the probe head as the probe tip remains in contact with the surface;

taking measurement reading of the surface when oscillating at different probe frequencies and hence accelerations;

10 wherein the deflection of the whole or part of the apparatus is determined from the difference between the known and measured dimensions; and

wherein the stiffness is derived from the acceleration and deflection.

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11. A method according to any preceding claim wherein the one or more factors which relate to the load in step (b) is determined from system variables of the apparatus.

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12. A method according to claim 11 wherein the one or more factors which relate to the load in step (b) is determined from the current applied to at least one motor in the articulating probe head.

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13. A method according to claim 11 wherein the one or more factors which relate to the load in step (b) is determined by double differentiation of the measurement data from the position measuring device in the

30 articulating probe head.

14. A method according to any of claims 1-9 wherein the one or more factors which relate to the load in step (b) is determined using a torque meter or

accelerometer.

15. A method according to any preceding claim, the method including the step of determining the offset of
5 the measurement path of the surface sensing device from a datum point, and wherein this offset is used in calculating the measurement error.

16. A method according to claim 15, wherein the
10 measurement error determined in step (c) is substantially proportional to $(L \cos \phi) \delta \theta$, wherein L is the distance from a datum point in the articulating probe head to the measurement path of the surface
15 sensing device, ϕ is the angle between the surface sensing device and an axis normal to the axis of a structure onto which the articulating probe head is mounted and $\delta \theta$ is the angular deflection of the mount.

17. A method according to claim 16, wherein the probe
20 is a contact probe and L is the distance between the tip of the surface sensing device and the centre of rotation.

18. Co-ordinate positioning apparatus comprising an
25 articulating probe head having a surface detecting device, wherein the surface detecting device is rotatable about at least one axis of the articulating probe head, the stiffness of the whole or part of the apparatus being known;

30 the apparatus being provided with means to determine one or more factors which relate to the load applied by the articulating probe head at any particular instant;

and wherein the co-ordinate positioning apparatus includes a processor adapted to determine the measurement error at the surface sensing device caused by the load, using the known stiffness of the whole or
5 part of the apparatus and the determined one or more factors relating to the load.